

Application No.: 10/521,906
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Remarks/Arguments:

Introduction

Claims 17-26 and 29, and 32-37 are pending. Claim 17 has been amended to include the limitations of dyeing the textile substrate with carbon dioxide where the carbon dioxide and the dyeing particles are under high pressure in a near critical or supercritical state. Support of this amendment may be found in the Specification at page 6, lines 19-21, lines 23-25). Claim 17 has also been amended to describe the materials of construction of the circumferential wall of the pressure dye vessel. Support for this amendment may be found in the Specification at page 6, lines 13-18. Newly added claims 36 and 37 further describe the materials of construction of the circumferential wall of the pressure dye vessel. Support for these claims may also be found in the Specification at page 6, lines 13-18. Support for newly added claim 35 may be found in the Specification at page 7, lines 10-15; Figs. 1-3. Claims 33 and 34 have been amended to further describe the axial elongation of the bonding frame. Support for these amendments may be found in the Specification at page 3, lines 21-24. No new matter is introduced with these amendments. Entry of the amendments is respectfully requested.

Discussion of the Invention

It is emphasized that the general idea to dye textile materials with the aid of carbon dioxide arose in Germany for about 25 years ago. However, up till now no one has succeeded in further commercializing this general idea!

The presently claimed invention relates to a specific advantageous construction and use of this specific construction for the dyeing of textile materials in carbon dioxide. The inventive idea of making and using this specific construction in this specific field is considered to be a critical new development of the applicant which for the first time has made it possible to build a commercial installation for performing this specific type of dyeing process.

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According to the new main claim, the device comprises a cylindrical pressure dye vessel with a closable lid on at least one of its end faces. A circumferentially closed bounding frame is provided which can be slid over the vessel in order to keep the lid sealingly in place during a dyeing process with carbon dioxide under supercritical conditions. Despite the high pressures and temperatures needed for the process of supercritical dyeing, the inventor has come up with the idea to manufacture the pressure dye vessel out of a composite fibre material which on the inside is coated with a layer of carbon dioxide resistant material (for example with a layer of stainless steel). This use of a composite fibre vessel in the field of dyeing textile materials with supercritical carbon dioxide advantageously is possible owing to the combination with the bounding frame. For example the vessel may comprise a thin stainless steel inner coating/vessel which is strengthened with uni-directionally circumferentially wound carbon fibres. The fibres are well able to take up all the radial forces caused by the high pressures and temperatures which occur during each dyeing cycle when the vessel is pressurized with the heated supercritical carbon dioxide.

Thus a new type of pressure dye vessel construction for this specific purpose is obtained which is about two to three times cheaper to build than for example a pressure dye vessel which entirely has been made out of stainless steel (carbon dioxide resistant material). Not only the building costs of the construction are substantially lowered owing to the invention, more importantly also the operational costs are substantially lowered. This is mainly caused by the fact that the amount of energy which is necessary to heat up the vessel during each dyeing cycle is largely reduced. Furthermore the thin-walled fibre reinforced vessel can be heated up very quickly up till the necessary supercritical dyeing temperature of between 90 and 150 °C. Owing to this low energy consumption and little time needed it is now possible to start each dyeing cycle at environmental temperature! This is quite an advancement. If one for example were to use a construction without the bounding frame, and thus be forced to use a thick-walled vessel entirely made out of steel, then the heating up to the necessary dyeing temperature of between 90 and 150 °C would take more than an hour and a corresponding large amount of

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energy consumption. Particularly because of this long time needed for bringing up the vessel to the necessary supercritical temperature, according to the state of the art one was forced to keep the vessel at a minimum temperature of at least 80 °C in between two subsequent dyeing cycles. Otherwise the number of batches of textile materials one was able to dye during a day would simply be too low.

Now this keeping of the vessel during the whole production day at a temperature above 80 °C, no longer is necessary. The invention makes it possible to start each dyeing cycle at environmental temperature which is prone to be somewhere between 20 and 30 °C. This saves a lot of energy and thus substantially lowers the operational costs.

There is another important advantage which comes together with the fact that the lower starting temperature for each dyeing cycle may advantageously also be the ending temperature of each dyeing cycle. Such a lower ending temperature has appeared to improve the quality of the dyed colors which have entered the textile materials during the supercritical dyeing process. For a better understanding of this improvement in dyeing quality, one needs to understand the process of dyeing with carbon dioxide better. This shall be clarified below.

At atmospheric conditions carbon dioxide is a gas. By increasing the temperature to approximately 120 °C and the pressure to approximately 250 bar, the carbon dioxide is present as one phase which is neither liquid nor gaseous, but supercritical. This is a unique combination of gas like viscosity and liquid like density. The density of the carbon dioxide can be tuned by small variations of the pressure and temperature of the carbon dioxide. This changes the solvent power of dye particles into the supercritical carbon dioxide: The low surface tension of the supercritical carbon dioxide and its high diffusivity allow penetration into even the smallest pores of textile materials during a dyeing cycle. Not only do the increased temperature and pressure make the carbon dioxide supercritical, it also has the effect of somewhat swelling up a textile material, for example polyester, placed in a vessel under these conditions. This opens up the pores of the textile material and makes it possible for the dyeing

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particles to enter the textile material. By subsequently reducing the pressure and temperature at the end of the dyeing cycle, the textile pores close themselves again and trap the dyeing particles. The lower the temperature can become at the end of each dyeing cycle, the better the quality of the dyeing process itself can be. Since the temperature according to the present invention is able to drop well below 70 °C at the end of each dyeing cycle, and in fact even to below 30 °C, the dyeing particles are adequately kept inside the textile material. Because of this improved entrapment of the coloring particles inside the textile material, it is now even possible to thoroughly flush the vessel clean at the end of each dyeing cycle without running the risk of accidentally flushing out some of the coloring particles also. In fact the quality of the dyed textile materials has proven to be even better than the same type of textile material which would have been traditionally dyed with water.

With this it is noted that traditional textile dyeing processes with the aid of water not only have a lesser dyeing quality, but also are very polluting for the environment. First of all large amounts of fresh water are needed and correspondingly large amounts of waste water are to be disposed. Each year worldwide about 7 billion kilos of textile materials need to be dyed. Only to dye cotton, the industry each year uses more than 1 billion tons of water, that is to say 4 million swimming pools. This is about 100 liters of water per kilo of textile. After completion of the dyeing this water is much polluted. In fact it is only reusable by intensive cleaning which is both expensive and energy consuming.

The use of the construction with the bounding frame in combination with the composite fibre vessel according to the present invention is a complete water free dyeing process. The operational costs with this construction have appeared to be 20 to 30% cheaper than traditional dyeing with water. Not only a large saving of water is achieved, also the electricity and oil consumption is less. For example traditional dyeing with water costs 120 kW per badge of 300 kilos of textile, whereas according to the invention this can be reduced to about 107kW. Furthermore, traditional dyeing with water costs about 120 liters of oil per badge, whereas the

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process according to the present invention costs less than 10 liters of oil. With the invention no energy intense drying of the textile material after completion of the dyeing cycle is needed. The textile materials come dry out of the vessel. The used carbon dioxide can almost entirely be recycled. The use of carbon dioxide is also attractive because it is non-flammable and non-toxic.

Furthermore, an important advantage is that a dyeing cycle according to the present invention takes up half the time of a traditional dyeing cycle with water.

All in all the above mentioned effects have lowered the operational costs to a level which is so low that now for the first time it is commercially interesting to start dyeing textile materials with supercritical carbon dioxide. Even though the device according to the present invention may be up to two to three times as expensive as a conventional dyeing machine with water, it is now for the first time possible to make the carbon dioxide process profitable nevertheless.

Section 103 Rejections

Claims 17-26, 29 and 33-34 were rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. Patent No. 6,491,518 to Fujikawa et al. (hereinafter “Fujikawa”) in view of U.S. Patent No. 4,471,949 to Ishii (hereinafter “Ishii”); U.S. Patent No. 6,491,882 to Van Den Berg et al. (hereinafter “Van Den Berg”); U.S. Patent No. 6,652,654 to Propp et al. (hereinafter “Propp”); U.S. Patent No. 5,722,783 to Stucker (hereinafter “Stucker”); and U.S. Patent No. 6,712,081 to Uehara et al. (hereinafter “Uehara”). Applicant respectfully traverses.

Fujikawa shows in figure 1 a pressure cylinder 1 having a top lid 2 and a bottom lid 3 together delimiting a treating chamber 4. In the lid 2 a high-pressure gas inlet/outlet hole 2A is provided. Column 6, lines 58 -62 describes that the lids 2 and 3 may be delimited by press frames 6 which may be a yoke type. Figure 1 shows a closed position, whereas figure 5 shows an open position of the press frames 6.

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The pressure cylinder of Fujikawa is intended for the treatment of semi conductor wavers with for example a treatment medium such as argon gas and nitrogen gas.

Fujikawa fails to teach or suggest that its pressure cylinder may be used for the refining of pieces of a textile substrate with a treatment medium under high pressure in supercritical or near critical state. For example, the dyeing of pieces of a textile substrate in supercritical or near critical CO₂ is not possible with the construction of Fujikawa.

Moreover, the materials of the several parts of the construction of Fujikawa which, during a treatment cycle, are in direct contact with the treatment medium, are not resistant against the supercritical or near critical treatment medium, like CO₂. Thus, any modification of Fujikawa would lead to an inoperable device. Accordingly, Fujikawa teaches away from the present invention.

Further, Fujikawa fails to disclose, teach or suggest how the lids are sealed in the pressure cylinder. In the absence of any discussion Fujikawa fails to disclose, teach or suggest that any special sealing arrangements need to be taken. Also, Fujikawa fails to disclose, teach or suggest that its lids have the ability to axially slide with respect to the cylinder. More likely, the yoke of Fujikawa is going to tilt during movement of the yoke, and subsequently hit the lids causing the pressure cylinder to be damaged. Thus, the teachings of Fujikawa are far removed from the claimed limitations of the present invention. Accordingly, Fujikawa fails to teach or suggest the present invention.

Ishii shows a pressure cylinder 2 having upper and lower plugs 3 and 4 for closing the upper and lower open ends of the pressure cylinder 2, to define a high pressure chamber 1 therein. The upper plug 3 is provided with a pressure inlet passage 5. Column 2, lines 55-60 describes that the axial force which acts against the upper and lower plug 3 and 4 are supported by threaded engagement of the upper and lower plugs 3 and 4 with the pressure cylinder or with the aid of a press mechanism.

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Ishii is designed for a so called hot isostatic pressing system generally used for sintering powdery material. Like Fujikawa, Ishii fails to teach or suggest that its system is suited for the refining of pieces of a textile substrate with a treatment medium under high pressure in supercritical or near critical state. Furthermore, retaining means comprising a bounding frame that is circumferentially closed for retaining the upper and lower plugged 3 and 4 in position, is not disclosed, taught or suggested in Ishii. Thus, Ishii fails to cure the deficiencies of Fujikawa. Accordingly, Fujikawa and Ishii, individually or in combination, fail to teach or suggest the present invention.

Van Den Berg shows a cylindrical high-pressure vessel 3 which is formed from a number of layers of composite material, such as glass, carbon or aramide fibers. The cylindrical high-pressure vessel 3 together with a housing 2, a foot piece 5 and a pressure ring 14, can be placed between a circumferentially closed yoke 4, made up of a number of parallel reinforcing plates.

Van Den Berg fails to teach or suggest that its vessel may be suited for the refining of pieces of a textile substrate with a treatment medium under high pressure in supercritical or near critical state. Instead Van Den Berg is used to sterilize foodstuffs, pharmaceuticals, and cosmetic preparations by treating them under high-pressure of between 1,000 and 15,000 bar, thus killing harmful microorganisms and enzymes without vitamins being damaged or the taste being impaired. Further, the construction of the sealings of Van Den Berg is different from the present invention. Looking at figure 3 of Van Den Berg, the outer seal 33 lying against a liner 25, that is to say the inside of the vessel 3, is static. This seal 33 is not allowed to slide, because otherwise the liner 25 will extend and get damaged. The inner seal 34 is a dynamic high-pressure seal between a piston rod 8 and a ring 24. Further, Van Den Berg fails to teach or suggest any lids which are able to slide inside the high-pressure vessel 3, as set forth by the present invention. Thus, Van Den Berg teaches away from the present invention.

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Accordingly, Fujikawa, Ishii and Van Den Berg, individually or in combination, fail to teach or suggest the present invention.

Prop is directed to a system for applying a material to a substrate. Critical or near-critical conditions are mentioned. Prop, however, fails to teach or suggest the device of claim 1 which includes, *inter alia*, a cylindrical pressure vessel with on at least one of its two end faces an aperture that can be closed by a lid, which aperture forms said feed aperture, a retaining means for keeping said lid in place in a sealing manner during treatment, where said retaining means comprise a bounding frame that is circumferentially closed, with two interconnected end pieces situated at a distance from each other, which end pieces in a closed position can be slid over said pressure vessel and thereby retain said end faces of said pressure vessel in its axial direction. Moreover, Prop fails to teach or suggest the method of claim 29 which comprises, *inter alia*, sliding said pressure vessel and the bounding frame out of each other and opening said lid. Further, Prop fails to teach or suggest that modification of its equipment, such as modification as suggested by the examiner in an attempt to arrive at the present invention, would still be suitable for the processing of textile substrates.

Stucker relates to a method for rejuvenating a pressurized fluid like supercritical carbon dioxide which has been used in for example dry cleaning of clothing. Stucker does not relate to the dyeing of textile materials with supercritical carbon dioxide. Furthermore, Stucker only shows and mentions a pressurized vessel for performing a dry cleaning process in general terms. Specific constructional details of the vessel construction are not shown or being mentioned in Stucker. Thus Stucker is merely another example of using supercritical carbon dioxide for the treatment of textile materials.

Uehara relates to a pressure processing device for the treatment of cast articles, sintered articles, manufacturing of semi-conductors and electronic parts, with the aid of supercritical fluids, in particular carbon dioxide. The problem Uehara tries to solve is to prevent that worn dust particles coming from a sliding sealing ring may enter the pressure processing device

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when its lid is opened or closed. In particular in the semi-conductor industry the entering of such dust particles would be very disadvantageous in the manufacturing process.

For this problem Uehara provides a number of solutions. For example, figure 11 shows an upstanding window like frame 203 inside which a pressure vessel is delimited. This pressure vessel is formed by an upstanding cylindrical wall with an upper lid 204 and a lower lid 206. Both lids are provided with axial extensions with circumferential grooves provided therein in which sealing rings 209 are placed. The lower lid 206 is provided with a labyrinth plate 208 with discharge passage grooves 211 (see figure 12). Preceding a treatment cycle, the press frame 203 is removed sideways, after which the lower lid 206 is taken away downwards in the axial direction. Subsequently, the objects to be treated, like the semiconductors, are placed in the pressure vessel and the lower lid 206 is put back in place, as is the press frame 203. Possible dust parts coming from the sealing ring 209 during the sliding movement of the lower lid 206 get automatically trapped in the discharge passage grooves 211 of the labyrinth plate 208 (see figure 15). During a subsequent treatment cycle these possible dust particles are immediately flushed out of the pressure vessel together with the used supercritical fluid.

Uehara is merely destined for the cleaning of objects like semiconductors in supercritical carbon dioxide. For this purpose it is important that the flushing medium, that is to say the supercritical carbon dioxide, is very clean, and does not contain any dust particles. Even small dust particles which may come loose of the sealing ring of the lid during the opening and closing thereof must be removed. For this purpose filters are placed in the pressure vessel for filtering the incoming supercritical carbon dioxide, and the above described trap is built around the sealing ring for catching possible worn dust particles of the sealing. Furthermore, the lower lid is built up out of two parts one of which has an axial sealing with respect to the other one such that its sealing ring does not have to make a sliding movement during opening and closing of this part of the lid.

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The pressure vessel and press frame of Uehara are placed standing up, that is to say their axial direction is vertically directed. Loading and unloading takes place via the lower lid. When the vessel is not pressurized, the lower lid because of its weight remains to rest on the press frame. In this condition the press frame needs to be removed sideways, such that the lower lid can be removed downwards. For this a lift installation is necessary which is able to displace the lower lid together with a number of treated objects. Before the lower lid together with the treated objects can be moved downwards, first of all the feeding lines for the carbon dioxide need to be removed.

Uehara does not relate to the dyeing of textile materials, In fact dyeing of large textile rolls with the pressure processing device of Uehara seems impossible. The construction of Uehara is hard to scale up for this purpose, which is necessary because textile rolls are known to be large, in particular they have diameters of 1 meter and lengths up to 3 meters. All this would make the vessel way up to more than 10 000 kg and also the press frame to more than 10.000 kg. A lift installation for displacing such heavy vessels and press frames are hardly practicable. Furthermore, when such a heavy vessel would rest with its lower lid on such a press frame, this press frame would be impossible to remove sideways because of the high friction. For this the vessel would need to be lifted slightly, which again would need a very expensive lifting installation. Furthermore such a heavy press frame would be very hard to remove sideways without touching the lids and or to damage the vessel. Finally it is noted that for the dyeing of textile materials relatively large amounts of supercritical carbon dioxide are necessary for which large feeding lines are necessary. In fact the amounts of carbon dioxide necessary for a dyeing process combined with the high pressure with which they need to be fed are no longer possible with flexible ducts as feeding lines.

Thus, Uehara does not relate to a device for the dyeing of textile materials with supercritical carbon dioxide nor is Uehara suitable for this purpose. The solutions offered in Uehara are far too sophisticated for the present invention and thus lead the reader away from

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using the device of Uehara in the field of dyeing of textiles. Furthermore Uehara does not relate to a vessel which is made of a composite fibre material which on the inside is coated.

In establishing a *prima facie* case of obviousness, the cited references must be considered for the entirety of their teachings. *Bausch & Lomb, Inc. v. Barnes-Hind, Inc.*, 230 U.S.P.Q. 416, 419 (Fed. Cir. 1986). It is impermissible during examination to pick and choose from a reference only so much that supports the alleged rejection. *Id.* It is only through hindsight reconstruction and selective picking and choosing does the Examiner attempt to reach the present invention through the combination of Fujikawa, Ishii, Van Den Berg, Propp, Stucker and/or Uehara. It is also well established, however, that hindsight reconstruction of a reference does not present a *prima facie* case of obviousness, and any attempt at hindsight reconstruction using Appellant's disclosure is strictly prohibited. *In re Oetiker*, 24 U.S.P.Q.2d 1443, 1445-46 (Fed. Cir. 1993). Such hindsight reconstruction by the Examiner is clear as Fujikawa, Ishii, Van Den Berg, Propp, Stucker and/or Uehara fail to teach or suggest the limitations of the subject invention.

Moreover, the Supreme Court addressed the standard for obviousness in its decision of *KSR International Co. v. Teleflex Inc., et al.*, 550 U.S. 389; 127 S.Ct. 1727; 167 L.Ed.2d 705; 82 U.S.P.Q.2d 1385 (2007). In order for an examiner to establish a *prima facie* case of obviousness after *KSR*, some degree of predictability is necessary. (82 U.S.P.Q.2d at 1395-97). *Takeda Chemical Industries Ltd. V. Alphapharm Pty. Ltd.*, 83 USPQ.2d 1169 (Federal Circuit 2007) is a post *KSR* decision in which the Federal Circuit articulated standards for establishing non-obviousness which again includes predictability of success. (83 USPQ.2d at 1176-79). Further, Section 2143.02 (II) of the MPEP states that "Obviousness does not require absolute predictability, however, at least some degree of predictability is required."

Clearly, the disclosures of Fujikawa, Ishii, Van Den Berg, Propp, Stucker and/or Uehara do not provide sufficient predictability or expectation to support a *prima facie* case of obviousness as none of these references, individually or in combination, disclose, teach or

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suggest the devices and methods for dyeing textiles with a carbon dioxide environment at high pressure in near critical or supercritical state. As none of these references, individually or in combination, disclose, teach or suggest the present invention, the examiner must provide some reasoning with some degree of predictability of success that one of ordinary skill in the art would modify Fujikawa, Ishii, Van Den Berg, Propp, Stucker and/or Uehara in an attempt to arrive at the present invention. The expectation and predictability to arrive at the present invention through Fujikawa, Ishii, Van Den Berg, Propp, Stucker and/or Uehara do not rise to a level that represents a *prima facie* case of obviousness. It is only through impermissible hindsight reconstruction by using the subject application as a roadmap does the examiner attempt to present a *prima facie* case of obviousness.

Accordingly, Fujikawa, Ishii, Van Den Berg, Propp, Uehara and Uehara, individually or in combination, fail to teach or suggest the present invention.

Summary

Therefore, Applicants respectfully submit that claims 17-26 and 29, and 32-37 are patentably distinct. This application is believed to be in condition for allowance. Favorable action thereon is therefore respectfully solicited.

Should the Examiner have any questions or comments concerning the above, the Examiner is respectfully invited to contact the undersigned attorney at the telephone number given below.

No excess claim fees are believed to be due with this submission. Nevertheless, the Commissioner is hereby authorized to charge payment of any additional fees associated with this communication, or credit any overpayment, to Deposit Account No. 08-2461. Such

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authorization includes authorization to charge fees for extensions of time, if any, under 37 C.F.R. § 1.17 and also should be treated as a constructive petition for an extension of time in this reply or any future reply pursuant to 37 C.F.R. § 1.136.

Respectfully submitted,

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